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IN THE UNITED STATES PATENT & TRADEMARK OFFICE

In re Application of:	)	PATENT
	)	
Mats LEIJON et al.	)	Group Art Unit: 2832
	)	
Serial No.: 08/973,210	)	Examiner: M. Nguyen
	)	
Filed: April 3, 1998	)	Atty. Docket: 66291-182-2

TRANSFORMER/REACTOR

DECLARATION UNDER 37 C.F.R. §1.132

I, Torben Aabo, hereby declare

1. I am President and Principal Engineer at Power Cable Consultants, Inc., where my mailing address is 220 Sweetman Road, Ballston Spa, New York, 12020.

2. My academic background is as follows:

Bachelor of Science degree in Electrical Engineering from Aarhus Technical College, Denmark and Graduate Work in Electrical Engineering and Industrial Management completed at Farleigh Dickinson University, New Jersey.

3. My industry experience is as follows:

I have over 30 years of experience in the area of high-voltage power transmission and distribution cable design, the most notable positions as follows:

Power Cable Consultants, Inc., Ballston Spa, NY **(1995 – Present)**

- President/Principal Engineer – Provide services to transmission and distribution cable using organizations, such as electric utilities, manufacturing corporations, and architect and engineering companies.

- Recent projects include the design of 115 kV XLPE transmission cable circuits
- Feasibility study of 230 kV XLPE transmission cable circuit
- Failure investigation of transmission cable system components

Power Technologies, Inc., Schenectady, NY **(1974 – 1995)**

- Cable Systems Group – Senior Engineer with responsibilities in the area of cable systems engineering and research associated with cable systems
- Principal instructor of Cable System Courses, and Cable and Accessories Failure Analysis Courses
- Developed an Extruded Dielectric Transmission Cable Course

Phelps Dodge Cable and Wire Company, Yonkers, NY **(1970 – 1974)**

- Research Engineer – High Voltage Research Laboratory
- Participated in the development and testing of new cable designs with improved insulation materials
- Participated in the optimization of cable extrusion equipment
- Application Engineer – Design of cable systems based on customer specifications
- Participated in field installation and testing of transmission cable systems

Royal Danish Airforce **(1967 – 1970)**

- Second Lieutenant – responsible for the calibration of air navigation equipment at field installations

I would consider my academic experience to be somewhat typical of one of "ordinary skill" in the high-voltage transmission cable art. My 30 years of industry experience is perhaps more extensive by 15 or 20 years that the person of ordinary skill in the high-voltage transmission cable art. With regard to the insulation systems used in high-voltage

transmission cables, I should note that the complexity of the material properties of the insulation systems gives rise to the need to have a fairly extensive academic background, and practical experience in insulating materials, manufacturing technology, and cable system operating environments.

4. I have provided a more detailed description of my professional background as Appendix A, attached hereto.

5. In preparing this Declaration, I have read and considered at least the following documents pertaining to the above-identified patent application:

   (1) Patent application – U.S. Serial No. 08/973,210;
   (2) Office Action of November 24, 2000;
   (3) Applicant's Response.

Furthermore, I have read the following references, all of which have been asserted as prior art against the present invention:

(1) Grimes et al. (U.S. Patent No. 5,455,551)

(2) Elton et al. (U.S. Patent No. 4,853,565)

(3) Takaoka (U.S. Patent No. 5,094,703).

6. Electric power transmission cables are used to deliver electric power from a generator over long distances to end-users of electricity. In designing electric power transmission cables, we are concerned with the most efficient transmission of power as well as the longevity of the cable itself.

7. In order to minimize the number of joints, electric power transmission cables are supplied in appreciable lengths (several hundreds of meters to kilometers), implying that the cables must be flexible in order to be wound on a drum for transportation.

8. Given the long distances that the electric power must be transmitted, cable engineers are particularly concerned about losses, such as resistive losses, and the insulation losses associated with the type of material used, over the length of the cable. As a general statement, the cross-section of the conductor can be increased, which will lower the resistance of the cable and accordingly the resistive losses. There are, however, other design constraints that must be considered.

9. All transmission cables have a core with a conductor, an insulation system, a shield or electric screen and a sheathing to protect the cable. The insulation system is provided around the conductor to ensure that the electric field is contained within the insulation. There are several types of insulation systems, the most commonly used being dielectric fluid impregnated paper. However, solid dielectric insulation systems have been used more frequently over the last 20 years since the material and manufacturing equipment guarantees the production of a high quality product.

10. In transmission cables, the insulation system consists in principle of three layers. First there is an electric conductive, or semi-conductive, layer surrounding the conductor. This semi-conductive layer is then firmly bonded to the second layer which is the insulation layer. This in turn is surrounded by and bonded to a third layer which is an electric conductive or semi-conductive material. The three layers are typically extruded materials, for example cross-linked polyethylene (XLPE) or ethylene propylene rubber (EPR). Important properties of the insulation material are low dielectric losses (i.e., low dielectric constant and loss angle), high dielectric strength, flexibility and permanence. However, the design of transmission and distribution cables as a whole eliminates the occurrence of partial discharges due to the use of the grounded electric screen, the purity of the insulation material, and the manufacturing procedures. Therefore, non-PD resistant materials like XLPE and EPR can be used.

11. Heat dissipation is of concern for transmission and distribution cable systems. The cables are installed direct buried in the soil or pulled into ducts or conduits that are installed in concrete or soil in the city streets. Since the cables are stretched out in length and not coiled up in a confined area, the heat transfer is through the surrounding environment to the ambient temperature. Therefore, the heat distribution is through the surrounding environment. The calculation methods used for rating of cable systems is given in the Neher-McGrath paper.[1]

12. Insulation layers are uniformly solid and designed for the maximum electrical stress for a given voltage. Therefore, no high electrical stress points will occur within the insulation. A stress point is a point of high electric field intensity and can be caused by an irregularity such as impurities or voids in the insulation, or by protrusions at the interfaces between adjacent

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1 J.H. Neher and M.H. McGrath. "The Calculation of the Temperature Rise and Load Capability of Cable Systems." AIEE Transactions on Power Apparatus and Systems, vol. 76, October 1957.

layers. The high-intensity fields present at such stress points can lead to an electrical breakdown of the insulation, which requires the cable to be repaired or replaced.

13. The two semi-conductive layers of the insulation system serve as concentric equipotential surfaces, the outermost kept at ground potential by contact with a grounded metal screen. The metal screen is often dimensioned to carry possible fault currents.

14. I have no practical experience in the field of high-voltage transformers. My field of expertise is in transmitting electrical power from one terminal point at which the generated power is present to another terminal point from which the power is taken.

15. Given the different operational environment, it is understandable that the transformer engineers are greatly concerned with heat due to the confined space of a machine, and with controlling any adverse effects caused by the presence of an intense magnetic field. It is my understanding that, from a winding perspective, a focus of transformer engineers is to minimize the losses caused by eddy currents in the windings that are induced by the magnetic field. Furthermore, machine designers place the windings directly against a metallic core, which is significantly different than in a power transmission setting where the cable is insulated by air.

16. In my opinion, the solid insulating materials used in power transmission cables (e.g., XLPE and EPR) would not be desirable for use in such a temperature-hostile environment of a transformer. These materials are acceptable for use in transmission cables due to the ease with which heat may be dissipated. However, I would not think that these materials would be desirable for use in a transformer, where there will be many windings adjacent to one another, and contained within a confined area, making dissipation of heat difficult.

17. With respect to the presence of the magnetic field, power transmission cables would be very undesirable for use in a transformer environment. The protective sheathing would provide an excellent eddy current path, since the protective sheathing is a conductive material, the eddy currents would be induced in the sheathing, leading to undesirable losses in the machine.

18. In light of the above discussion, it is my opinion that an electric power transmission cable would not work as a winding in a high-voltage transformer. We design transmission cables to satisfy a completely different set of constraints.

19. In the Examiner's Action, the Examiner asserts in his grounds for rejection that Grimes discloses a transformer with windings, cooling ducts and duct sticks. The Examiner asserts that Grimes does not disclose the specific cable used for windings, but Elton discloses the electric cable configured for use with the electric device. The Examiner refers to column 1, lines 15-25 of Elton.

20. Elton describes a power cable. The cable has a conductor, a pyrolyzed glass tape semi-conducting layer, an insulation layer, a pyrolyzed glass tape semi-conducting acting as a protective sheath. The conductive outer layer is typically provided for electrically shielding the cable and for protecting the cable from physical damage.

21. The conductor described in the present specification is configured to be operable as a winding in a transformer and to reduce the losses caused by eddy currents that are induced by the presence of a magnetic field. Eddy currents are not considered a serious source of problems in the high voltage cable of Elton, since the cable described therein is not intended for use in an environment where there is a high magnetic field present. The problems addressed in Elton and the problems associated with the present invention are caused by different physical phenomena, having different impacts, and therefore, requiring entirely different solutions.

22. In the present invention, the conductor is surrounded by a magnetically permeable electric field confining insulating covering. The present invention does not require a conductor shielding layer and a conductive (or non-conductive) outer protective layer.

23. It seems to me that the Examiner may have confused two distinct problems, and how these problems may be addressed. The Examiner stated that one of ordinary skill in the art would be motivated to employ the cable of Elton as a winding in the machine of Grimes. However, when addressing insulation, engineers employ design considerations to address the insulation system as a whole. When addressing eddy currents, engineers employ design considerations to address the eddy currents. One cannot simply ignore the potential problems caused by eddy currents in a machine when designing an insulation for such a system. Elton can do so

because he is not concerned with the problems caused by eddy currents when designing a cable that will be used as a transmission and distribution cable, and therefore, will not be used in the presence of a high magnetic field. Again, the design problems concerning an insulation system for a transmission cable, and those concerning a winding for a high-voltage transformer are distinct. Accordingly, different solutions are required for the two different applications. If the arrangement of Elton would be used in a high voltage machine such a transformer, the high magnetic field would induce substantially eddy current in the screen. Eddy currents cause losses in the machine, and these are manifested as thermal energy (i.e., heat). Accordingly, given the confined space of a transformer, I would think that the presence of the electrically conductive layer, as well as the outer conductive sheath, would contribute to thermal and efficiency problems if used in a transformer.

24. It should also be appreciated that the outer metal layer in Elton is capable of carrying an induced current. In a cable employed in a transmission and distribution system, induced currents are negligible. However, in a high voltage machine such as a transformer, the high magnetic field would induce a substantial eddy current in the conductor. Eddy currents cause losses in the machine, and are manifested as thermal energy (i.e. heat). Accordingly, given the confined space of a transformer, I would think that the presence of the conductive layer, and for that matter, the electrically conductive layer, as well as the outer conductive sheath, would all contribute to thermal and efficiency problems if used in rotating machine.

25. It should also be noted that there are significant differences in cables used for the transmission and distribution of electricity and power cables used for carrying power to machines. Examples of both begin with multiple strands of electric conductors called wires and the bundle of wires is surrounded with an electrical insulation. However, at that point the specifics are unique to each application. Some designs require an outer protective covering made of metal. Others do not. Some cables are designed for high current and accordingly have a large conductor cross-section. However, at the same power level a cable for high voltage would not require as large a cross-section.

26. The specific design of a cable for a winding in a transformer would not be made simply by selecting components from different cables, but would require careful analysis and selection based on such analysis. A designer of such a cable would not, at the time the invention was

made, make the substitution suggested by the Examiner. Now that a winding for a high voltage transformer has been made, it seems simple and straightforward. However, in my view, the idea to use a high voltage cable in a transformer is a striking and radical application for a cable.

27. As a cable engineer, I cannot agree with the Examiner that it would have been obvious to take the cable described in Elton and to use it to replace the winding in Grimes. This is because the cable in Elton would fail if the outer layers are not removed. In addition, it would not be desirable to modify the system of Elton by removing the unnecessary components, because the arrangement of Elton is an insulation system for cables. Accordingly, when I look at a cable, I look at it as a system as a whole, not as several distinct parts. The cable insulation system of Elton as a whole is designed to operate in a particular way for a particular purpose and in a particular environment. Cable engineers design cable systems that provide solutions to particular operational problems. The cable described in Elton solves a particular problem, namely bringing power to a machine or other power operated device. Employing Elton as a winding in Grimes does not account for the design constraints facing the transformer designer, nor would I expect it to.

28. I consider the cable designed by the ABB inventors to be a cable winding specifically designed for use in the unique environment of a high-voltage transformer. I do not consider the cable winding to be analogous to an electric power transmission cable. I consider it to be a special-purpose cable designed specifically for use as a winding in a transformer. I am unaware of any electric power transmission cable that could be operational as a substitute for the cable winding in a high-voltage transformer according to the present invention. Quite simply, windings for high-voltage transformers and cables for the transmission and distribution of electrical power require solutions to two distinct sets of problems. Furthermore, I cannot imagine any one solution that could solve both problems.

29. I cannot agree with the Examiner that it would have been obvious to employ an essentially high voltage device, such as the power transmission and distribution cable described in Elton, in a device such as the device shown in Grimes.

30. This belief is based on the fact that the problems associated with high voltage operation in a power cable are entirely different from problems associated with high voltage operation inside of a transformer, and the focus of the designer is thus entirely different. One does not, for example connect the transformer windings directly to the transmission cable, but connections are made through intermediate terminations. This is because the power delivery cable has a physically different structure than a transformer winding.

31. The Examiner asserts that it would have been obvious to provide the winding in the machine of Grimes with the insulation system of Elton. Such a combination would be based on the assumption that one of ordinary skill in the transformer art would employ the insulation system from a high voltage cable used for transmission and distribution in the winding of a conventional transformer. In my opinion, there is no suggestion in Grimes that such a substitution would be desired.

32. Takaoka discloses a conductor having insulators on insulated strands. The purpose of the feature in the reference is to reduce the skin effect in associated with self-induced currents in a transmission and distribution cable. It has nothing to do with eddy currents in the winding of a transformer. Takaoka is simply a conventional device which does not employ a high voltage cable as a winding. As set forth in Takaoka, the insulated and uninsulated strands are for the purpose of reducing the skin effect associated with self-induced currents in a transmission and distribution cable.

33. The dimensional elements noted by the Examiner have to do with the operation of a transmission and distribution cable. As a cable engineer, it stands to reason that transmission and distribution cables of varying types may have similar sizing considerations. However, it is not clear to me how such sizing considerations would translate from the transmission and distribution art to the transformer art.

34. The ABB invention employs a cable capable of supporting a high voltage as a winding in a transformer. Extra precautions have been taken in order to protect the cable from overheating while operating in such a device. These precautions are not necessary in a conventional transmission or distribution line. Thus, one does not merely substitute a cable for paper and oil impregnated conductor for a winding in a transformer, because the technical and design

problems associated with the fabrication of a winding in transformer are different from those associated with the fabrication of a cable for transmission or distribution of electricity.

35. A number of critical ideas had to be combined in order to make a workable and practical system which has now been successfully commercialized. It was only when the critical characteristics and functions were identified that it became possible to proceed to assemble the necessary components and material to build a workable and practical system.

36. I further state that all statements made herein to my own knowledge are true and that all statements made herein on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such any willful false statements may jeopardize the validity of the application or any registration resulting therefrom.

Torben Aabo

Torben Aabo

8 June 2001

Dated